

The Center for Building Performance and Diagnostics (CBPD)

Carnegie Mellon University

High-performance buildings should enhance worker effectiveness, communication, comfort, and productivity

Center Mission and Rationale

The Center for Building Performance and Diagnostics (CBPD) conducts research, development, and demonstrations to increase the quality of and user satisfaction with commercial buildings and integrated building systems, while improving cost, time, and energy efficiency. The Center believes that high-performance buildings must provide appropriate physical, environmental, and organizational settings to accommodate changing technologies and workplace activities. The Center's members are prominent leaders in the market for high-performance buildings.

The main goals of CBPD are to —

- Study international developments in high-performance buildings. CBPD is building an international knowledge base on advanced office buildings in Japan, Germany, the United Kingdom, Canada, the United States, and France.
- Develop innovative products. CBPD has developed a list of major design features and decisions that are critical to the advanced office.
- Develop an innovative building delivery process centered on a team approach to design.
- Improve educational curricula and materials on systems integration for building performance.
- Design and construct the Intelligent Workplace (the first in a series of CBPD demonstration projects).
- Complete a state-of-the-art demonstration project.
- Complete a "breakthrough building" with a private owner or developer.

This demonstration project will further introduce CBPD findings into the mainstream practices of the building industry.

Research Program

CBPD's investigators have performed significant research in the area of building performance and diagnostics. Selected research activities include —

- Major performance-design decisions for offices, courthouses, and university laboratories
- Energy-efficient revitalization of inner-city housing
- Impact of HVAC, lighting, and enclosure zoning and control on the energy consumption of commercial buildings
- Development of integrated computational design and simulation environments for concurrent performance analysis
- Long-term analysis of the thermal, visual, and acoustical performance of buffer spaces (e.g., atria)
- Studies of daylight/electric light interfaces and development of an expert system to simulate and evaluate the visual quality of indoor rooms
- Empirical assessment and computer simulation of sound transmission between adjacent spaces.

The CBPD research program has several distinguishing characteristics. The Center contends that occupied buildings are the most reliable validation field for the performance of individual components and their impact on occupants (as opposed to the study of one building-

*A National
Science
Foundation
Industry/
University
Cooperative
Research
Center
since 1992*



Computer-aided images provide an advance look at the Intelligent Workplace, a 7000 sq. ft. living laboratory integrating advanced building systems and components, to be constructed atop Margaret Morrison Carnegie Hall on the Carnegie Mellon University campus. (CAAD rendering, Azizan Aziz)



Professor Ardeshir Mahdavi confers with doctoral student Paul Mathew over energy simulation data. These simulations have played a crucial role in developing the design of this innovative facility.

performance issue in isolation from others in a "conventional" laboratory setting).

Additionally, CBPD radically departs from the standard linear process of building delivery and "patchwork" integration of building systems. The Center advocates a team decision-making process for building design and delivery. This process ensures a more fully integrated building design that provides environmental quality and responds to changing technologies and the changing needs of occupants.

Finally, CBPD research involves an in-depth analysis of interactions and interrelationships between different building-performance descriptors and building systems.

Special Center Activities

Together with the Advanced Building Systems Integration Consortium, which serves as the Center's Industrial Advisory Board, CBPD researchers are planning a series of demonstration projects designed to progressively introduce CBPD's research

findings into the mainstream building industry. The Intelligent Workplace, the first in this series of three demonstration projects, will satisfy the need for a dedicated research environment that addresses the necessity of integrative building-performance evaluation.

When completed, the Intelligent Workplace not only will house building performance and diagnostics instrumentation, but it will itself become the

subject of building performance research. The facility will function as a dynamic laboratory and a high-performance computing workplace. The Intelligent Workplace will assimilate experimental design innovations and high-performance products and assemblies into all building systems (enclosure, mechanical, telecommunications, electrical, and interior systems).

CBPD research and development activities have fostered several collaborative efforts between sponsor companies to develop improved building products and systems. One example of the Consortium's responsiveness to innovative design directions for industry is the Personal Environments Module™ (or PEM™), which was developed by Johnson Controls Inc. and CBPD. The PEM™ allows for greater individual environmental control by ducting fresh air to each workstation and permitting the occupant to control air speed, temperature, and direction, along with other environmental factors.

Sponsor companies are working together to realize advances in the following areas:

acoustic panel systems; ceiling and wall integration; unified networking of data and phone; power monitoring; modular data/voice/power outlet boxes for walls and furniture; energy effectiveness of user control systems; integrated facility-management software; water-based (nontoxic) coating technologies; application of low-CFC insulation materials in roofing; and use of recyclable plastics in office environments.

The Center's corporate sponsors include major U.S. construction companies (with worldwide operations) along with manufacturers of instrumentation, controls, telephone and lighting equipment, and software. Federal sponsors include the Department of Defense, the Department of Energy, the Environmental Protection Agency, and the General Services Administration. The Center has several European companies as partners.

Other accomplishments of the Center are highlighted below:

- The CBPD offers the only program in the United States with a graduate concentration in building performance and diagnostics.
- The CBPD was awarded the Three Rivers Environmental Award in 1996, which recognized the Intelligent Workplace project for its excellence in advancing environmental quality in Western Pennsylvania.
- The American Institute of Architects (AIA) recently awarded the CBPD faculty an honorable mention in the 1992 Education Honors Program for its course sequence entitled *Design for Building Performance: An Integrative Approach*.
- The CBPD was awarded the Nuckolls Fund Grant for Lighting Education.
- The CBPD was awarded the AIA award (Pittsburgh chapter) for "Architecture for Art's Sake," a research project sponsored by the National Endowment for the Arts.



Graduate student Dale Morrissey records daylighting measurements on the future site of the Intelligent Workplace. Such data are used during the early stages of the design process to predict visual performance with computer simulation studies.

Center Headquarters

Center Director: Dr. Volker Hartkopf
 The Center for Building Performance and Diagnostics (CBPD)
 Carnegie Mellon University
 Pittsburgh, PA 15213
 Phone: (412) 268-2350
 Fax: (412) 268-6129
 E-mail: vho2@andrew.cmu.edu

Center Evaluator: Dr. Luis Vargas
 Graduate School of Business
 University of Pittsburgh
 314 Mervis Hall
 Pittsburgh, PA 15260
 Phone: (412) 648-1575
 Fax: (412) 648-1693